

ABSTRACT

The present invention includes carbon nanotubes whose hollow cores are 100% filled with conductive filler. The carbon nanotubes are in uniform arrays on a conductive substrate and are well-aligned and can be densely packed. The uniformity of the carbon nanotube arrays is indicated by the uniform length and diameter of the carbon nanotubes, both which vary from nanotube to nanotube on a given array by no more than about 5%. The alignment of the carbon nanotubes is indicated by the perpendicular growth of the nanotubes from the substrates which is achieved in part by the simultaneous growth of the conductive filler within the hollow core of the nanotube and the densely packed growth of the nanotubes. The present invention provides a densely packed carbon nanotube growth where each nanotube is in contact with at least one nearest-neighbor nanotube. The substrate is a conductive substrate coated with a growth catalyst, and the conductive filler can be single crystals of carbide formed by a solid state reaction between the substrate material and the growth catalyst. The present invention further provides a method for making the filled carbon nanotubes on the conductive substrates. The method includes the steps of depositing a growth catalyst onto the conductive substrate as a prepared substrate, creating a vacuum within a vessel which contains the prepared substrate, flowing H₂/inert (e.g. Ar) gas within the vessel to increase and maintain the pressure within the vessel, increasing the temperature of the prepared substrate, and changing the H₂/Ar gas to ethylene gas such that the ethylene gas flows within the vessel. Additionally, varying the density and separation of the catalyst particles on the conductive substrate can be used to control the diameter of the nanotubes.